BRIDGE NO. 00761
(Sikorsky Memorial Bridge)
State Route 15 over the Housatonic River
Milford
New Haven County
Connecticut

HAER NO. CT-177

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, Pennsylvania 19106

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HISTORIC AMERICAN ENGINEERING RECORD

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Location: State Route 15 Bridge over the Housatonic River
Milford
New Haven County, Connecticut

UTM: 18.658896.4567655
Quad: Milford, Connecticut 1: 24,000 scale

Dates of Construction: 1939 - 1940

Engineer: William G. Grove and B.D. Freedman

Present owner: State of Connecticut, Connecticut Department of Transportation, Newington, Connecticut

Present use: Vehicular bridge

Significance: The bridge is an essential link between the Merritt Parkway and the Wilbur Cross Parkway. It is eligible for listing on the National Register of Historic Places as the northern terminus of the Merritt Parkway, which is listed on the National Register of Historic Places. The bridge has two unique engineering features: it was the longest span of open steel grid deck bridge in the U.S, and the use of T-shaped, one-leg bents was considered an innovative solution to ensure navigational clearances beneath the bridge.

Project Information: The Connecticut Department of Transportation plans to remove and replace Bridge No. 00761 to increase traffic capacity and reduce long term maintenance costs of the aging structure. To mitigate the adverse effect, this documentation was undertaken, in accordance with the 23 August, 1996, Memorandum of Agreement between the Federal Highway Administration, the Connecticut State Historic Preservation Office, the Advisory Council on Historic Preservation and the Connecticut Department of Transportation.

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I. SUMMARY DESCRIPTION

Bridge No. 00761 is located on the Housatonic River approximately three miles north of Sikorsky Airport in Stratford, on State Route 15, connecting Stratford and Milford, Connecticut. The bridge is a 12 span, 1,824-foot long steel, riveted plate, through-girder bridge with a 26-foot wide, steel open-grid deck roadway in each direction. It has a 4-foot wide center island, 1.5-foot inside shoulders, and no outside shoulders. Sloping upward from west to east, the bridge provides a navigational clearance of 85 feet above mean high water on its eastern end. A navigational channel and adjacent railway line run beneath the bridge at its eastern side. The major structural elements of the bridge consist of three longitudinal girders supported by steel and reinforced concrete piers and abutments. For the purposes of consistency, the 11 bridge piers are numbered from the west to the east.

Abutments and Piers

The eastern and western abutments are roughly U-shaped (in plan and section) reinforced concrete structures. The eastern abutment is founded directly on rock, while the western abutment rests on a pile foundation. They are slightly decorated with triple grooving on the north and south external elevations. They rise to a height equal to that of the longitudinal girders on the bridge superstructure. The abutments are connected to the superstructure via rigid fixed (as opposed to pin-connected) "shoes."

The piers in the navigation channel (piers 8 and 9) are founded on rock 45 feet below low water via concrete caissons. Piers 10 and 11 are founded on rock on either side of the railroad right of way. The remaining piers are founded on paired groupings of 62-foot-long steel H-piles. The reinforced concrete pile caps are topped concrete tie beams that unite the piling groups. At water level, they are shaped in the form of gothic arches, while the tops of the tie beams rise to form conical, mushroom-shaped forms at the base of the steel piers. These forms serve as bases for the steel pier bents.

The steel piers, with the exception of piers 5, 8, and 9, are pinned at the base to accommodate longitudinal movement. Pier 5, a steel bent, and piers 8 and 9, steel towers, are fixed by bolts at their bases to resist the longitudinal movement of the superstructure. The tower piers (8 and 9) consist of two cantilever arms of equal length supported atop a single column, cellular steel leg constructed in a hollow cruciform shape. The overturning force at the base of the each of the these towers is resisted by anchor bolts embedded up to 50 feet into the concrete pier bases.

Piers 1 through 7, 10 and 11 are all built to a basically common design. Each bent is approximately 40 feet wide and consists of pairs of built-up steel box-shaped columns topped by a built-up steel box-shaped cap beam with tapered ends. Horizontal and diagonal bracing is

provided by built-up beams connected by riveted gusset plates at the tops and bottoms of the columns. The columns appear to be built up from three rolled steel channel sections with the fourth side, facing the interior of the bridge, made up of riveted lattice work. The same method of construction is used for the bracing elements. The cap beam has vertical stiffeners at the columns and its lower element is open-webbed to permit drainage of any water that enters from the superstructure.

Superstructure

Starting at the western end of the bridge, the superstructure is divided into four sections. The first section, from spans 1 to 3, consists of a three-span structurally continuous unit, with each span being 128 feet long. The second section (spans 4 through 7) is a four-span structurally continuous unit, with 160-foot long spans. Spans 8 through 10 comprise a three-span cantilever unit, consisting of a main span of 224 feet, flanked by 160-foot-long anchor spans. The 224-foot long span rises above the navigation channel and is made up of two cantilever arms with a 160-foot long suspended span. The final section (spans 11 and 12) is a two-span structurally continuous unit, with each span having a length of 128 feet. Span 11 carries the superstructure over the Waterbury line of the Metro-North commuter railroad, with a vertical clearance of 40 feet.

The superstructure consists primarily of three longitudinal riveted, built-up plate girders, spaced at 29 feet, 6 inches on centers. The center girder is 100 inches deep and the fascia girders are 91 inches deep. All the girders have evenly spaced vertical stiffeners. The top flanges of the girders extend above the roadway and make up the fascia curbs and median island. Modern metal railings and guard rails have been added to these beams at the roadway level. All the longitudinal plate girders are supported on fixed bearings atop the piers and abutments. One end of each of the continuous span units is supported by a pin and hangar assembly at piers 3, 7, and 10, as are the ends of the 160-foot long suspended span between piers 8 and 9.

The girders support two 26-foot wide roadways consisting of 5-inch open steel grid deck set on 21-inch deep rolled stringers spaced at 4 feet 4 inches on centers. The stringers are supported on 33-inch deep rolled floor beams spaced at 32 feet on centers along the bridge. The floor beams are framed into the longitudinal girders by means of riveted angle plates and knee bracing. Lateral stiffness for the superstructure is provided by diagonal bracing, consisting of rolled steel I-sections, connecting the bottom webs of the floor beams and longitudinal girders by means of riveted plates. Additional lateral stiffness is provided by further cross bracing connecting the pier cap beams to the fascia girders of the superstructure.

II. HISTORICAL CONTEXT

The location of Bridge No. 00761 appears unrelated to the early crossings of the Housatonic River. The first recorded river crossings between the towns of Milford and Stratford were ferry crossings in the early eighteenth century. The Stratford ferry crossed the Housatonic River roughly three miles south of Bridge No. 00761, in the vicinity of Boston Post Road (U.S. Route 1). Another ferry crossed the river approximately a mile north of Bridge No. 00761. By 1849, a rowboat ferry did operate from a point just south of the bridge's location, from Ryder's Landing, Stratford. This ferry crossed to Baldwin Station in Milford, a flag stop for the Naugatuck Railroad. It is believed that these ferries were no longer in operation after 1880[1].

Bridge No. 00761 was constructed in 1939 and 1940 to connect the Merritt Parkway and the Wilbur Cross Parkway. The bridge became the second bridge over the lower Housatonic River, preceded by the U.S. Route 1 Bridge, which was built as a drawbridge in 1804 and replaced numerous times since. The development of Bridge No. 00761, therefore, is closely linked to the history of the parkway system in Connecticut.

The history of the parkway system in Connecticut can be traced to 1929, when a state parkway planning commission was established through the efforts of Schuyler Merritt, a former congressman and resident of Stamford. In 1931, the state legislature passed a bill mandating construction of a parkway system paralleling U.S. Route 1 along coastal Connecticut. The primary purpose of the parkway system was to relieve traffic congestion on U.S. Route 1, which had become increasingly worse as auto ownership swelled after World War I.

Construction of the Merritt Parkway began in 1934, funded by Fairfield County, state bonds and the federal Public Works Administration. Initially, the Merritt Parkway was proposed to tie into U.S. Route 1 before reaching the Housatonic River. During the planning process, however, there was a realized need to create a continuous parkway system to the Massachusetts state line, so the Merritt Parkway was realigned to a point approximately three miles upstream of its originally conceived location. In 1938, construction of the Wilbur Cross Parkway began, in Milford. The Merritt Parkway was completed at the Stratford terminus in 1940, the same year that Bridge No. 00761 was completed. Construction of the Wilbur Cross Parkway continued until its completion in 1941.

The ceremonial opening of the bridge over the Housatonic River on September 2, 1940 was also the ceremonial opening of the Wilbur Cross Parkway. The bridge was not considered to be part of either parkway, but an independent construction project. At the time, only 10 miles of the Wilbur Cross Parkway were finished. Traffic on the bridge, like the rest of the parkway system (State Route 15), has been limited to non-commercial passenger and combination vehicles weighing less than 3402 kg (7,500 pounds).

Bridge No. 00761 was originally named the Housatonic River Bridge. The naming of the bridge was not without controversy. Several names historically attached to the area were promoted by various factions. Proposals for a bridge name included the following: naming it for the revolutionary war hero, Major General David Wooster; naming it for a naval hero of the War of 1812, Commodore Isaac Hull; naming it for Moses Wheeler, who ran the first ferry across the river near the location of the Washington Bridge; naming it for the governor who first supported and promoted the construction of the parkway system in Fairfield County, Governor Raymond E. Baldwin; and, finally, naming it for the former American Indian settlement on the Stratford side of the river, the Oronoque. No consensus on any of these options could be reached and so the bridge came to be called the Housatonic River Bridge[2].

The initial cost estimate for Bridge No. 00761 was $1,500,000. For reasons of economy, efforts were made to reduce the cost of the bridge below that by the use of an open steel grid for the roadway deck. The open steel grid deck was lighter in weight and less costly than the usual concrete roadway. Use of the steel grid deck also had the effect of lowering the overall structural costs while speeding up the construction process. The final cost of the bridge was approximately $1,000,000, which included a contract price of $410,000 for the substructure and $520,000 for the superstructure[3]. The bridge was financed with the aid of a 45 percent federal Public Works Administration grant.

Tolls were established on the Merritt Parkway in 1939 through an act of the state legislature. Toll booths were first set up on the Parkway in Greenwich, Connecticut. Subsequently, two tollbooths were included in the construction of Bridge No. 00761 (then the Housatonic River Bridge), which were located just east of the bridge on the Milford side. The initial toll was 10 cents in each direction. In the first 11 hours that the new bridge was open, 24,500 cars paid a toll, and $30,000 was collected in the first three weeks of toll operation[4]. By the 1980s, public support for the use of toll booths to raise funds waned. Initially, it was planned that the toll booths would raise enough funds to pay for the cost of collecting tolls, to pay interest on the bonds and retire the bonds for the Parkway in a 15-year span. The toll system was continued for about 45 years and revenues were used to support other roadway projects. The state legislature ultimately decided in the mid-1980s to discontinue and dismantle the toll booths. The Boothe Memorial Park Foundation in Stratford negotiated to take possession of the toll booths located immediately east of the Housatonic River Bridge and moved them to the Boothe Memorial Park in July, 1988.

In its 57 year history, the original design elements of Bridge No. 00761 have not been significantly altered. Due to controversy over safety and maneuverability on the steel grid deck, the bridge deck was covered with steel plates and surfaced with asphalt. The bridge was rehabilitated in 1985, but the planned installation of new pin and hangar assemblies did not take place and, in 1987, the open grid steel deck was reestablished.

The historic and economic significance of the aircraft industry to the Stratford area prompted a proposal to rename Bridge No. 00761 in the late 1980s. Igor I. Sikorsky, an aviation pioneer and innovative mechanical engineer, had founded his Sikorsky Aviation production and research facility near Sikorsky Memorial Airport in Stratford in 1929. In 1955, Sikorsky Aviation moved to a new 250 acre site on the northwest side of Bridge No. 00761, becoming something of a local landmark. In 1989, State Senator George Gunther proposed an amendment to a bill before the state legislature to rename the bridge for Igor Sikorsky. The amendment, part of Special Act 89-51, passed in July of that year, coinciding with the 100th anniversary of Igor Sikorsky's birth.

III. ENGINEERING CONSIDERATIONS

One Leg Bent Design

One leg bents were used at piers 8 and 9 because of their location within the navigation channel of the river. The channel is 150 feet wide and a 150 clearance was maintained to allow boats to pass under the bridge. In order to achieve proper clearance, that portion of the bridge needed a 177 foot rise above the water along its centerline. The average clearance of the bridge over mean high water is 90 feet. If conventional two leg bents with a rectangular pier were used, the clear span across the navigation channel would have needed to be 250 feet. Since steel girder panels were used for the deck support, the 250-foot length was considered too long for optimum functioning of the overall design. With the one leg bents angled 58 degrees to the navigation channel, the pier structures used less open water space and the navigation channel clear span could be reduced to 224 feet in length.

Pier Design

The center girders of the roadway rest directly over the columns and piers for the bridge and their weight is distributed to the pier through the column. However, the reactions of the outside girders, located 29.5 feet from the centerline, introduce a considerable bending movement against the column under a condition of live load on one side of the roadway and no load on the opposite side. Since this is a condition that could be expected to occur regularly, it was a prominent factor in the design of the bridge. In addition to the unbalanced live loads, the wind and other lateral forces on the spans produce an overturning moment (or force) at the top of the bent columns. Therefore, the bridge was designed over the navigation channel with the canopy tower floorbeam at the top consisting of two cantilever arms of equal lengths with one point of support at the top of the columns. To secure the tower to the pier, anchor bolts are provided, some 5 inch and some 4 inch in diameter. The smaller ones were placed near the centerline of the bridge and are used primarily to prevent overturning in the direction of traffic, due the forces noted above. These

same unbalanced live loads and lateral forces also act on the cylindrical piers, which were designed to withstand the overturning moments as well as other overturning forces resulting from the effects of ice, current and wind acting on the piers themselves.

Open-Grid Steel Deck Design

The bridge designers decided to use the open steel grid deck primarily because it was less costly than a reinforced concrete slab design and was much lighter. The steel grid weighs 20 pounds per square foot (psf) as compared with 54 psf for a concrete filled steel deck or 100 psf for an eight-inch reinforced concrete slab deck. The Connecticut State Highway Department had used open grating floors on three smaller bridges between 1937 and 1939. They felt that those bridges had performed well and they had received few complaints from drivers, except from drivers of the occasional horse-drawn vehicle. Another anticipated advantage of the open grid steel deck was that snow would not accumulate and, in theory, ice would melt off quickly as vehicles crossed the grid and their tires created friction. Therefore, the expense of snow removal could be saved and the surface of the bridge should have remained safer for vehicle travel.

As the bridge was being completed, an unexpected problem arose. Smoke from the New York, New Haven and Hartford trains, which passed beneath the bridge on the Milford shore, presented an unexpected problem. The smoke penetrated the open grid deck, potentially obscuring drivers' vision, and over the long run, could be detrimental to the ironwork. In response, William G. Grove, the bridge's primary designer, incorporated a smoke barrier into the design of the eastern end of the bridge.

Construction Technology

Foundation work was simple and without notable incident[5]. The east abutment and piers eight and nine were set on rock while the remainder of the piers were founded on steel H-piles. A pneumatic caisson was used for pier 8, but pier 9 was put down in an open cofferdam. Because of the railroad tracks under span 11 on the east bank of the river, the steel erector elected to start work on this end of the bridge where steel could be brought in on a siding. Spans 11 and 12 were thus built using a locomotive crane in combination with a tractor crane. With these two spans in place a starting platform was available for a deck traveler which rode on the center and north line of girders. As the deck traveler moved westward, it was assisted on the river spans by a derrick boat. While most of the steel came in by railroad, the steel for bents 6, 7, 8, and 9, and the girders for spans 7, 8, 9, and 10 were delivered by barge.

Erection of the river spans was the most difficult part of the project. After spans 8, 9, and 10 were erected, operations shifted to the west end of the navigation channel where the derrick boat, unaided, raised bent 7 and the three girders of span 8. These bridge elements, including the 32-

foot long cantilever arms into the channel span, were 192 feet in length. The girders came to the job in two sections and were the heaviest erection pieces, although the largest single girder on the bridge is 160 feet long. The two girder sections were connected on the barge and lifted as one piece weighing 76 tons. The derrick boat set bent 6 and that operation completed its use. The deck traveler, standing on the cantilever of the span 7 girders that extended out into span 6, was able to place the bent at pier 5. The remainder of the steel to the west was erected using the deck traveler with the same "reach out" procedure.

A.I. Savin Construction Company of Hartford, Connecticut, built the entire substructure, with the exception of the construction of the pneumatic caisson at pier 8, which was sublet to Senior and Palmer of New York City, New York. The American Bridge Company of Pittsburgh, Pennsylvania, an arm of the Carnegie Steel empire, built the superstructure.

IV. PERSONNEL

Bridge No. 00761 was designed by William G. Grove, an associate highway engineer, and B.D. Freedman, both in the office of L.G. Sumner, Engineer of Bridges and Structures of the State Highway Department. The design phase of the bridge was initiated under the guidance of then Commissioner of the Highway Department, John A. Macdonald. The project was completed under the direction of William J. Cox, State Highway Engineer and E.C. Weldon, Deputy Highway Commissioner. Construction was under the supervision of Leo Conaty, resident engineer, and Howard Ives, assistant resident engineer, both in the office of A.W. Bushnell, Director of Engineering and Construction.

John A. Macdonald had been appointed the new Commissioner of the Highway Department in 1923 by Governor Templeton, remaining until 1938. From Putnam, Connecticut, Macdonald had a civil engineering degree from Valparaiso University, Indiana. Prior to his appointment, Commissioner Macdonald had been a concrete salesman and, from 1917-1923, had served as a deputy commissioner of the Department of Motor Vehicles. Immediately, Commissioner Macdonald called for improvement and completion of the existing highway system because of "tremendously increasing highway traffic". During this period railroads continued to decrease in importance and automobiles increasingly took their place. Under Commissioner Macdonald, many roadway standards and classifications were established, including 100-foot wide rights-of-way for all new construction, central landscaped medians, adjacent public utility rights-of-way, elimination of all grade crossings, and improved sight lines.

In 1938, Commissioner Macdonald was replaced by William J. Cox, who served until 1947. Born in Portland, Oregon in 1896, Cox graduated from Washington and Lee University in 1918,

followed by graduate studies at L'Universite de Montpelier in France and Yale University, where he was a professor of engineering until becoming Commissioner. His term was characterized by an increasing emphasis on planning and further refinements in highway technology.

Other notable individuals associated with Bridge No. 00761 include Governor Raymond E. Baldwin, who promoted the bill authorizing the funding for the parkway system in Fairfield County, Governor Wilbur E. Cross, who officially opened the bridge in 1940 and for whom the Wilbur Cross Parkway is named, and the engineer/architect George Dunkleberger. Dunkleberger, who was responsible for the aesthetic design of the Merritt Parkway bridges, was consulted in the design of Bridge No. 00761.

FOOTNOTES

[1]Lewis G. Knapp. Interview by Thomas P. Klin. Stratford Historical Society, Stratford, Connecticut, 2 October, 1997.

[2]"Battle Looms Over Naming of New Housatonic River Bridge as Residents Search Historical Records to Find Suitable Name." *Bridgeport Post*, 23 March, 1939.

[3]William B. Grove. "One-Leg Bents Support Steel Grid Deck." *Engineering News Record,* 12 September, 1940, p 75.

[4]Uncited newspaper articles at Stratford Historical Society archives.

[5]Grove.

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A. Engineering Drawings

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B. Historic Views

Historic views and photographs were sought at the Connecticut Department of Transportation archives, the State Library, the Special Collections at the University of Connecticut, and at the Stratford Historical Society. Historic views and photographs were located at the Stratford Historical Society.

C. Interviews

Lewis G. Knapp, Town of Stratford Historian. Interview by Thomas P. Klin. Stratford Historical Society, Stratford, Connecticut, 2 October, 1997.

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LOCATION MAP